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ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

RESULTS OF EXPERIMENTS ON COTTON IN ALABAMA.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

INTRODUCTION.

This bulletin has been prepared at the request of the Committee of the American Association of Agricultural Colleges and Experiment Stations which has in charge the collective exhibit of the Experiment Stations at the World's Fair in Paris in 1900. The Alabama Station has been engaged in the experiments on cotton since 1883 and a large amount of valuable material has accumulated in reference to its cultivation, chemistry, botany, diseases, entomology and physiology, and because of the variety of experiments conducted it was deemed appropriate for this station to prepare this work on cotton.

During the period covered by the experiments the following bulletins have been issued by the Station that relate to cotton:

In volume 1 there are 33 bulletins and 6 of these contain the results of experiments on cotton. 122 pages.

No. 5—Cotton experiments. 16 pages.

No. 13—Microscopic study of certain varieties of cotton. 20 pages.

No. 16—Fertilizer experiments with cotton. 20 pages.

No. 17—Dry application of Paris green and London purple for the cotton worm. 18 pages.

No. 21—A new root rot disease of cotton. 11 pages.

No. 22—Experiments with cotton. 24 pages.

No. 23—Co-operative tests of fertilizers on cotton. 61 pages.

No. 27—Black rust of cotton. 18 pages.

No. 33—Cotton. 1 2pages.

No. 34—Co-operative fertilizer tests on cotton. 46 pages.

No. 36—Some leaf blights of cotton. 32 pages.

No. 40—Cotton experiments. 15 pages.

No. 41—Some diseases of cotton. 65 pages.

No. 42—Co-operative soil tests of cotton. 34 pages.

No. 45—Insects of cotton. 5 pages.

No. 52—Cotton experiments. 2 pages.

No. 55—A new disease of the cotton; cotton boll rot. 13 pages.

No. 56—Experiments in crossing cotton. 51 pages.

No. 57—Fertilizers required by cotton as determined by the analysis of the plant. 16 pages.

No. 62—Cotton experiments. 7 pages.

No. 65—Co-operative seed tests. 4 pages.

No. 69—Fungus diseases of the cotton. 1 page.

No. 71—Experiments with foreign cottons. 12 pages.

No. 76—Cotton experiments. 23 pages.

No. 78—Co-operative fertilizer experiments with cotton in 1896. 48 pages.

No. 83—Hybrids from American and foreign cottons. 32 pages.

No. 91—Co-operative fertilizer experiments with cotton in 1897. 63 pages.

No. 99—Cotton rust. 31 pages.

No. 101—Experiments with cotton in 1898. 19, pages.

No. 102—Co-operative experiments with fertilizers on cotton in 1898. 75 pages.

Climatology of the cotton plant. Issued by the United States Weather Bureau. 70 pages.

The above list comprises 37 bulletins, containing a total of 986 pages.

In the prosecution of the work indicated by the above bulletins the following parties have been more or less intimately connected with and responsible for the results of the experiments:

W. H. Chambers, Agriculturist.
W. C. Stubbs, Chemist.
J. S. Newman, Agriculturist.
J. J. Barclay, Agriculturist.
N. T. Lupton, Chemist.
P. H. Mell, Botanist and Meteorologist.
G. F. Atkinson, Mycologist.
B. B. Ross, Chemist.
A. J. Bondurant, Agriculturist.
J. M. Stedman, Mycologist and Entomologist.
J. F. Duggar, Agriculturist.
F. S. Earle, Mycologist.
J. T. Anderson, Associate Chemist.
B. M. Duggar, Assistant Mycologist.
James Clayton, Assistant Agriculturist.
T. U. Culver, Assistant Agriculturist.
A. L. Quaintance, Assistant Entomologist.
T. D. Samford, Assistant Botanist.
George Clark, Assistant Botanist.
A. M. Lloyd, Assistant Botanist and Meteorologist.

A number of experimenters located in different parts of the State who had charge of the co-operative fertilizer tests on cotton have also contributed much valuable material.

P. H. MELL,
Director.

Ala. As a rule prairie soils are in poor mechanical condition and need vegetable matter rather than commercial fertilizers. Their improvement is especially marked when a leguminous crop, as mellilotus or cowpeas, is plowed in. Some of the best of these soils need drainage rather than fertilization. On the poorer soils, observation indicates that cotton seed meal is advantageous, and the few experiments made on bald prairie suggest that phosphate may increase the yield of cotton there.

The acid condition of certain soils found in many parts of the State may render ineffective commercial fertilizers that may be applied to them. For acid soils, which, when moistened and brought in contact with blue litmus paper, change the paper to a reddish color, the remedy is usually to be found in drainage or in the application of lime or marl, supplemented by the usual fertilizers.

To make commercial fertilizers afford a maximum profit it is desirable to use them on soils which are in good mechanical condition, especially as regards the supply of moisture in periods of drougth. Generally the cheapest means of accomplishing this improvement in the mechanical condition of a soil is by the growth of humus-forming crops, and especially by the growth of leguminous plants as food for stock or fertilizer for the soil, or for both purposes combined.

DISEASES OF COTTON.

BY F. S. EARLE.

The systematic investigation of cotton diseases was first undertaken at this station on the appointment of Dr. Geo. F. Atkinson as Biologist in the Fall of 1889. It has been continued as opportunity offered by the various officers filling this position up to the present time. Six bulletins* have been published dealing exclusively with the diseases of cotton besides minor notes in a number of the other publications of the Station.

The article on Diseases of Cotton (pp. 279-316) in the treatise on The Cotton Plant published as Bulletin 33, of the Office of Experiment Stations, United States Department of Agriculture, was written by Dr. Atkinson after severing his connection with this Institution, but it was based almost entirely on work done while here, and it may be considered as his final summing up of the results obtained while here.

In the following pages a brief account will be given of the present state of our knowledge of each of the diseases of cotton that has been detected in this State, drawing freely on the matter already published, but also incorporating the results of my own study and observation during the past four years.

In studying the diseases of cotton it has seemed desireable to prepare a Bibliography giving the title, place and time of publication, and where possible, a brief outline of the contents of the papers that have been published on this subject in different parts of the world.

*For a detailed statement of the contents of these bulletins see chapter on Bibliography p. 324.

Diligent search has discovered a surprisingly meager literature considering the great importance of cotton as an agricultural crop. This Bibliography is appended as a part of this paper. It is probable that some titles have been omitted especially as library resources have been limited, but the fact is evident that almost nothing has been published outside of the United States; and that of our own Experiment Station, only two have given the subject serious attention. The United States Department of Agriculture has from time to time, published papers and notes on cotton diseases. The first noteworthy one was the paper by Townend Glover on "Accidents and Diseases of the Cotton Plant," in the Annual Report for 1855, and the last is the admirable monograph on "The wilt Disease of Cotton, Watermelon and Cowpea," by Dr. Erwin F. Smith, just issued as Bulletin No. 17, of the Division of Vegetable Physiology and Pathology. It is gratifying to learn that during the past Summer one of the members of this Division has been assigned to special work on cotton diseases.

In volumes 5 and 6, of the Tenth Census, which are devoted to the cotton industry of the United States there are chapters devoted to diseases for each of the cotton States which contain much valuable information on distribution.

A list of the fungi that have been detected as growing on cotton or on the cotton plant in any part of the world has been prepared and is added as a part of this paper. Many of the species named are saprophytes and are probably of little or no economic importance; but since so many supposed saprophytes have the power under certain conditions of becoming partial or facultative parasites it is thought best to include them in this list.

In taking up the different diseases as a matter of convenience those will be considered first that more obvious-

ly affect the root and stem, second, those affecting the leaves, and third, those affecting the bolls. Under the first heading we have Root Knot, Sore Shin, Wilt, and Anthracnose of the Stem. The diseases of the leaves are Rust, Red Rust, Angular Leaf Spot, Leaf Blight and Mildew. The diseases of the bolls are Anthracnose, Boll Rot and Shedding. Under each of these diseases reference will be made by number to the more important papers bearing on it that are mentioned in the bibliography.

ROOT KNOT.*

Syn. Root Galls.

In common with many other cultivated plants at the South the roots of cotton are subject to the attack of a microscopic nematode worm, *Heterodera radicicola* (Greef.) Muell. The larval nematodes invade the tissues of the rootlets where they become encysted, and their presence causes a gall like swelling of the root. The gravid females are large enough to be seen with a hand magnifier when the fresh galls are broken open. Each female produces from 100 to 200 eggs, and the life cycle is completed in about one month, thus allowing seven or eight generations during the growing season. Under favoring conditions they therefore increase very rapidly. The galls or knots are usually about the size of a pea, but by confluence they may become much larger. If only a few are present no great damage is done, though the part of the root below the knot usually after a time rots away. If the knots are very numerous the nutrition of the plant is seriously deranged, growth is feeble or ceases entirely, and finally the rotting of the roots causes the premature death of the plant.

Cotton is less seriously affected by "root knot" than

* Bibliography, Nos. 4, 10, 13. See also Ala. Sta. Bull. 9.

many kinds of vegetables and some kinds of fruit trees. The cotton farmer therefore has less cause to dread it than the orchardist or trucker to whom it is often a veritable scourge. It however injures the cotton quite seriously, and it is so widely distributed, occurring more or less in most of the sandy and alluvial soils of the Gulf States that its total injury to the cotton crop must be very considerable. As Atkinson has pointed out, its greatest injury to cotton takes place when it occurs, as it often does, in the same fields with the fungus producing cotton wilt (see p. 296), since the breaking down of the root tissue by the nematode serves to aid the wilt fungus in obtaining an entrance.

Numerous experiments have been conducted at this Station during the past four years with the hope of finding some means of freeing the soil from this pest. The organism seems to be remarkably resistant, and so far the experiments have largely given only negative results. It has been suggested* that kainit and lime applied to soils would greatly reduce the injury from root knot. A number of tests were made with these substances without result. In one case both lime and kainit were applied to a plot at the rate of 2000 lbs of each per acre. The plot was planted to okra and every plant developed root knot.

With the soil in pots in the green house carbon di sulphid has given encouraging results. When 10 c. c. have been injected into 12 in. pots before planting the percentage of root knot has been greatly reduced. It has not been found safe to inject it near the roots of living plants either in pots or in the field. Some field experiments have been tried with it but with less marked

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*J. C. Neal—The Root Knot Disease of the Peach, Orange and other Plants in Florida, U. S. Dept. of Agr. Div. of Entomology, Bull. 20.

results. In 1899 two plots were treated with it. On one plot 10 c. c. were injected once in two feet in each direction and in the other a like quantity was injected once a foot. Both plots and a check plot were planted to cow peas and okra. The place selected chanced to be rather free from the nematodes as but few of the plants on the check plot were affected. Well developed cases were found however on all three of the plots in about equal proportions. No benefit could be detected from the treatment. It is to be noted however, that the workman in injecting the carbon di sulphid carelessly left the holes made by the injector open so that part of the fumes probably escaped.

In 1899 plots were also prepared with varying quantities of sulphur broadcasted and plowed in two weeks in advance of planting. The amount of sulphur used varied from two to sixteen pounds per square rod. All of the plots were planted to cowpeas and okra. The okra failed to germinate when more than 4 lbs. of sulphur per rod was used. The cowpeas were not affected, germinating and growing well on all of the plots. Where the heaviest applications were made the fumes of the sulphur could be detected easily, when the sun was hot, at any time during the summer. None of the cowpeas in this experiment suffered seriously from the nematodes. It did not prove to be a good plant for the experimental work, but well developed cases of root knot were found on all the plots. In fact it so happened that the plot receiving 16 lbs. of sulphur developed more cases than some of the checks. It is also interesting to note that root tubercles developed freely on this heavily sulphured plot and that on one of the plants underground perithecia developed of the fungus causing the cowpea wilt, *Neocosmospora vasinfecta tracheiphila*, E. F. Smith.

The only soil treatment that has proved at all efficacious in reducing the numbers of this pest has been a perfectly clean fallow continued through two growing seasons. During the summer of 1896, certain plots were given perfectly clean cultivation, no growth of any kind being allowed on them. In the spring of 1897, a portion of these plots were planted in okra and other vegetables. Root Knot developed on all of them but in only about half the normal quantity. On the other plots the clean fallow was continued throughout the Summer of 1897, till September, when celery plants were set out on them. Celery is the most susceptible of all vegetables to the nematode root knot disease, but the plants remained entirely free from the trouble. An absolutely clean fallow extending over two Summers is hardly a practical remedy on account of the cost, and on account of the injurious effect on the soil. Probably equally good results would be secured by allowing only such plants to grow on the land as are known to be entirely free from the nematodes. None of the grasses or small grains are known to harbor them, so by planting to wheat, oats or rye in the Fall and following with German millet or sorghum in the Summer, and continuing this for two or three years it seems that the land should be quite thoroughly cleaned of them. It would be necessary to take great care to keep down all succulent rooted weeds that might serve to harbor the nematodes. This style of cropping would prove very exhausting on most of our cotton lands, and on the lighter of them it would not be practicable. It is unfortunate that our best known soil improving plant, the cowpea, should prove a nurse plant for the nematode but such is the case, and its frequent use cannot be advised on soils known to be infested by them. The velvet bean, (*Mucuna utilis*), a new soil improving plant that has attracted much attention during the past few years,

it is claimed is nearly or quite exempt from its attack. If this claim proves to be well founded, and there is strong evidence in its favor, then oats followed by velvet beans for two seasons will not only practically rid the land of nematodes but will vastly increase its fertility.

SORE SHIN.*—DAMPING OFF.

Young cotton plants are sometimes observed to fall over and die. This is known as damping off. It usually occurs in wet, unfavorable weather. Atkinson has shown that this disease is caused by a fungus that penetrates the young stems just below the surface of the soil, causing their tissue to become soft and decomposed. In some cases, especially as the plants get a little older, only one side of the plant becomes affected. The stem is not cut off, but an ulcerous depression is formed. Such plants may ultimately recover, though their growth is retarded. This is the condition sometimes known as Sore shin. From the fact that the fungus causing this trouble has not been found to produce spores or other fruit bodies, Atkinson called it the "Sterile Damping Off Fungus," to distinguish it from other fungi that cause the damping off of young seedlings. He found similar sterile mycelia attacking many other plants besides cotton and that they are widey distributed as damping off agents. One of these sterile fungi has since been studied by B. M. Duggar as causing a serious disease of the sugar beet, and by F. C. Stewart as causing a stem rot of carnations. These investigators agree in placing these sterile fungi in the form genus *Rhizoctonia*, but their studies have not yet progressed sufficiently far to admit of assigning specific names to the different forms. Their observations and experiments suggest liming the soil as a possible remedy.

* Bibliography, Nos. 10, 12, 13, 19, 29, 31.

The *Rhizoctonia* of cotton is very widely distributed. It probably occurs in every cotton field in the State. During wet, unfavorable springs it kills a great many plants, and yet owing to the habit of very heavy seeding and of only chopping to a stand after the plants begin to form rough leaves, it is doubtful if the disease often causes serious loss. Atkinson claims that, like the nematode root knot, it sometimes does harm by aiding the wilt fungus to gain an entrance into the stem of the cotton plant.

The suggestion for liming the land will doubtless be useful in all cases where the soil is acid, as in the case with many of our sandy lands. We have no direct observations, however, as to its effect on this disease in the cotton field. Running the smoothing harrow obliquely across the rows as soon as the ground can be stirred after each rain while the plants are small, will tend to check the disease by quickly drying the surface layer of the soil in which the *Rhizoctonia* is most active. On lands that are free from rocks and trash such harrowings will not injure the stand, but will prove the cheapest and most efficient form of cultivation.

COTTON WILT.*

Syn. Frenching.

This disease has sometimes been called "Frenching," but it is best to drop this meaningless term, especially as it has not come into general use. There are a number of closely related diseases of cultivated plants, as of the bean, the cow pea and the watermelon that are known by the expressive name of "Wilt," and it seems best to make the usage uniform.

The disease is caused by a fungus parasite, *Neocosmospora vasinfecta* (Atk). E. F. Smith, that lives in the

* Bibliography, Nos. 10, 13, 39, 40, 41.

soil and gains entrance to the vascular bundles of the stem through the roots. The disease may be present in the plant for some time before it becomes externally manifest, except in the somewhat dwarfed growth, but its presence can be easily detected by splitting open the stem. In the healthy stem the internal tissue is white, but when the wilt disease is present it becomes stained a dark brown. This staining of the tissues, particularly of the vascular bundles, is always present, but the external symptoms are somewhat variable. In typical cases when the disease is progressing rapidly the growth of the fungus plugs up the ducts, thus cutting off the water supply from the leaves, causing them to suddenly wilt. At first this wilting may only be noticed on certain branches. In some cases the branches on one side of the plant wilt and die, while those of the other side remain green and possibly even mature their crop. Usually the whole top becomes involved within a few days after the wilting is first noticed and the plant soon dies. Instances have been observed where nearly all the plants in fields several acres in extent have died in this manner by mid-summer. At other times the disease seems less active. The leaves do not wilt, but gradually die and fall off, beginning with the lowest ones. The margins of the leaves first turn yellow and then brown, the color changes extending down between the main veins in V shaped areas. The green color may persist along the veins for some time, but the leaf finally falls. New shoots will sometimes start from near the base of the plant after the top is quite badly diseased, for the fungus seems to grow upward from the point of attack much more rapidly than it does downwards so that the roots remain comparatively healthy, excepting the ones by which the fungus first entered the plant.

The fungus found in the tissues of these wilted plants belongs to the form genus *Fusarium*, and it was described by Atkinson, who first detected it as *Fusarium vasinfectum*. Within the tissues it produces only minute oval spores, but on culture media it develops the curved septate spores characteristic of this genus. Dr. Erwin F. Smith first detected the perfect, ascigerous form of the fungus which consists of bright red, minute, Nectriaceous perithecia, thickly or thinly scattered over the underground part of the stem and the larger roots. The Ascospores are nearly spherical, one celled and at maturity dark brown, with a thick and more or less roughened epispore. These characters do not admit of placing it in any of the previously described genera of the *Nectriaceae* so that Dr. Smith has described it as a new genus under the name *Neocosmospora*.

The fungi causing the wilt of cowpeas and of watermelons are so similar in structure to the cotton wilt fungus that after much careful study Dr. Smith is unable to separate them specifically. The failure of cross inoculations, and the results of field tests and observations, all show that, though so closely alike in form, the fungus from one of these hosts is not able to infect either of the others. He therefore considers the watermelon and cowpea fungi as being physiological varieties of the cotton fungus.

This disease is a very serious one. It lives over in the soil from year to year, and when once established in a field it continues to spread and grow worse as long as cotton is planted on the land. No remedy is known, and it becomes necessary to discontinue growing cotton on lands where the disease makes its appearance. How long the disease will persist in the soil is not known. Few direct experiments on this very important point have been made, but instances have been reported by in-

telligent farmers where fields infested with this disease have been planted in other crops as corn or oats for two seasons, and yet when again planted to cotton on the third year the disease still made its appearance, though not so bad as before the change of crop. Some melon growers claim that five to seven years' rest is necessary for infested lands, if indeed, it is ever safe to plant again where melons have once wilted.

So far as known, the cotton wilt attacks no other plant except okra. The fact that it is at least physiologically distinct from the wilts of cowpeas and watermelons is an important one practically since it admits of planting cowpeas as a restorative crop on lands infested with the cotton wilt. If the disease was communicable from one of these plants to the other as was at one time feared this would not be permissible. Dr. Smith's opinion of their physiological distinctness seems to be well founded. It is fully supported by some field observations of my own. In July, 1898, I was called to investigate an outbreak of this disease on the farm of Mr. James Hall at Midway, Bullock Co., Ala. In a field of about three acres three-fourths of the cotton was dead or dying. Mr. Hall said that it had been dying for two months, and in order not to leave the ground entirely vacant he had been replanting with cowpeas. At the time of my visit the peas were growing luxuriantly among the dying cotton without showing the slightest sign of disease. Mr. Hall wrote me in the fall that the peas remained healthy to the end of the season, showing that in this case at least they did not contract the disease from the cotton.

A certain garden lot in Auburn, belonging to Mr. C. E. Little was planted to cowpeas, following oats, during 1897 and 1898. In both seasons nearly all of the peas died from wilt, showing the land to be thoroughly infested with the cowpea wilt fungus. In 1899 Mr. Little

kindly allowed me to plant some cotton in this garden, as well as cowpeas, snap beans and velvet beans. Half or more of the cowpeas and a few plants of the snap beans contracted the wilt, but the cotton and the velvet beans remain entirely healthy.

Sound, healthy cotton roots seem to have a certain power of resistance to the wilt fungus. It is not uncommon to find plants that have evidently been attacked through a single root only. It is possible that the fungus usually gains entrance through injured roots, as where they are broken by the plow. The injury caused by nematodes and the ulcers caused by the *Rhizoctonia* or "sore shin" fungus also seem to serve to enable the wilt fungus to attack the plants.

This disease is quite widely scattered. It is known to occur in Arkansas, South Carolina, Alabama and Florida. In this State it is widely distributed throughout the southern half. It has been found in Montgomery and in the south edge of Lee county, but so far it has not been reported north of a line drawn through these two points with the exception of an isolated outbreak at Athens, in the Tennessee valley.

The most important practical point remaining to be learned in connection with this disease is the length of time the fungus can exist in the soil if no cotton or okra is planted. The fact that the similar cowpea wilt (See p. 293) developed on a plot that had received at the rate of more than 1,500 pounds of sulphur per acre does not make experiments for destroying the fungus in the soil seem encouraging.

ANTHRACNOSE OF THE STEM.*

The fungus causing Anthracnose of the bolls, *Colletotrichum Gossypii* South, sometimes attacks the

*See Bibliography, Nos. 5, 6, 8, 10, 13.

stems, causing a blighting of the bark over extensive areas. The term anthracnose is usually associated with diseases producing little sunken pits or ulcers as in the case of the anthracnoses of the grape and the raspberry. There is no such appearance in this case. The bark at first turns a uniform reddish brown and finally dies. The foliage soon shows the effect of the disease, yellowing and finally dying and falling much as with the rust. The latter disease, however, does not usually affect the stems. They remain green and frequently put out new leaves after the old ones have all fallen. This stem blight often occurs in connection with the rust, but again it may occur on vigorous plants and on soils where the rust does not occur. This disease is rather prevalent, though it has attracted but little attention, its effects being usually confounded with those of the rust. No remedies can be suggested.

This fungus is an active parasite, attacking at various times nearly all parts of the cotton plant. It has been known to damp off seedlings, it develops on the seed-leaves, on the bark, on the leaves and bracts and especially on the bolls. It is a serious pest and annually causes much loss.

RUST.*

Synonyms: Black Rust, Yellow Leaf Blight, Mosaic Disease.

This disease has attracted more attention than any of the others affecting cotton. It causes the premature falling of the leaves, thus preventing the proper maturing of the crop. It occurs very commonly in the older cotton growing States, usually, though not always, on the thinner sandier lands. The losses occasioned by it when present vary from 5 per cent. to 50 per cent. or more of

* Bibliography Nos 5, 6, 9, 10, 13, 18, 20—25, 26, 29, 31, 32, 33, 34

the crop, and as it is so widely distributed the total loss is very great. The disease is a complex one, depending in part on unfavorable soil and weather conditions, and in part on the attacks of several species of fungi. None of these seem to be able to grow on perfectly vigorous, rapidly growing cotton foliage, but during hot, showery weather they develop rapidly on any leaves where there is reduced vitality from any cause, as where the foliage has prematurely ripened from the effects of drouth or of a poor sterile soil. The disease is really a remarkable one as illustrating the marked effect of soil conditions and the general vigor of the host plant in enabling it to resist the attacks of a certain class of parasites. It may be safely asserted that this disease cannot attack a cotton plant that is in full, vigorous growth, but that a sudden checking of growth and lowering of the vitality from any cause will render it liable to serious injury if the weather conditions favor the growth of these fungi. The species of fungi usually connected with this disease are *Macrosporium nigricantium* Atk., an undescribed species of *Alternaria*, *Cercospora gossypina* Cke. and *Colletotrichum Gossypii* South. The exact course of the disease varies with the weather conditions. In some cases the leaves of affected plants first exhibit a more or less mottled yellow color. This is the condition that suggested the name of "Mosaic Disease" that Dr. Atkinson applied to it in his later publications. When a period of warm summer rains suddenly follows a long drouth in July or August, this mosaic condition will be hardly apparent, but the seemingly healthy leaves will be seared and blackened by the rapid growth of these various fungi. Under these conditions the leaves often wither and fall very quickly, leaving the stalks entirely bare. In such cases a second crop of leaves is sometimes produced so that fields that were quite bare in early Sep-

tember become green again in October, but such leaves are produced at the expense of reserve food material that should go to developing the bolls, and they are an injury rather than a help to the crop, as frost usually comes before the new leaves have had time to elaborate a new food supply. It more often happens that the leaves do not all fall at first, but that many of them, though badly blotched and spotted by the fungi, still hang on for some time and assist in ripening the more advanced bolls. Of course such plants do not set a top crop so that even if all the formed bolls on the plant when it is attacked ripen, the crop is seriously reduced. The quality of the fiber, too, is often injured on badly rusted plants. It is light and chaffy and the same bulk of it weighs less than cotton from healthy plants.

It seems certain that the damage done by this complex disease is mainly due to the growth of the associated fungi. These attack and destroy the tissues of leaves that would otherwise continue to perform their functions. The physiological disturbances due to drouth or other unfavorable conditions would disappear with the advent of more favorable weather, and the plant would resume its normal growth but for these fungus attacks. On the other hand it is equally certain that perfectly vigorous plants have the power to resist these fungus attacks, and that when the soil is in the proper condition of tilth and fertility the cotton plants will pass unharmed through conditions of weather sufficiently unfavorable to induce serious outbreaks of rust on less favorable soils. This has been forcibly illustrated for several years past in the sandy fields south and west of Auburn. Owing to the passage of a stock law the fences have been removed and the old fence rows have been grubbed out and plowed and planted with the rest of the fields. These fence rows are practically new land.

The soil is rich from the accumulation of vegetable matter for many years, and its mechanical condition is such that it resists drouth and keeps the plant constantly growing. The old fields on the other hand have been cropped in cotton year after year for many years till their vegetable matter and other elements of fertility have been exhausted. These soils are in no condition to resist drouth, and with the advent of hot dry weather in mid-summer growth ceases and the foliage hangs limp and wilted during the noon-day heat. Now when rains occur the fence row cotton grows with increased vigor, while that in the poor, worn-out fields soon shows the unsightly spots of rust, and for the past three years it has been bare of leaves and practically dead by the middle of September, while that of the bordering fence rows, subjected to identically the same climatic conditions, has remained green and vigorous to the end of the season.

The obvious remedy then for cotton rust lies in ameliorating unfavorable soil conditions, and securing a state of fertility that will support continued vigorous growth of the plant. Judging from a wide series of observations and an extended correspondence the usual inciting cause of cotton rust is the inability of the soil to withstand drouth. In other cases the cause is just the reverse and rust is induced by lack of drainage. Cotton roots require a well areated soil, and they are quickly affected by standing water or by too great a rise of the water-table. In such cases drainage would prove an efficient remedy. There are still other classes of soils with abundant vegetable matter and where the mechanical conditions all seem favorable where cotton rusts badly in ordinary seasons. In these cases the trouble seems to come from a lack of sufficient potash in the soil, and applications of kainit or other potash fertilizers remedy the

trouble. In fact the good effect of potash has often been so marked that kainit has come to be considered as almost a specific for this disease. It has been held that this favorable effect of kainit might be due to the effect of the salts it contains on the hydrostatic pressure and surface tension of the soil moisture. Recent experiments seem to show that it is rather the specific effect of the potash since muriate, sulphate and other potash salts are found to be effective about in proportion to the per cent. of potassium they contain. Thus 50 pounds of muriate is fully as effective as 200 pounds of kainit per acre in enabling the plants to resist rust. On drouthy soils applications of potash alone will often prevent rust during favorable seasons, but at other times its effects will be much less marked. On the Station Farm during 1896 and 1897 potash fertilizers gave almost no effect in preventing rust. In 1898 its effect was very markedly beneficial. In 1899 its good effects were plainly visible but were much less marked than in the previous year. On these drouthy soils the mechanical conditions need ameliorating in addition to supplying the needed chemical elements. This is best done by plowing under leguminous soil improving crops. Of these the cowpea is the best known, and on most soils it is exceedingly satisfactory. For the southern half of the State, and especially on sandy soils where the nematode root knot trouble prevails, the recently introduced velvet bean promises to be a marked improvement. On very poor soils both of these crops should be liberally fertilized with acid phosphate and potash, as otherwise the growth obtained will be too small to accomplish much in the way of soil improvement. It is not necessary to apply nitrogenous fertilizers, since these crops have the power of gathering nitrogen from the atmosphere, which accounts for their great usefulness in increasing soil

fertility. For growing either of these crops it is necessary to miss growing one crop of cotton on the land. The peas can usually be most economicaly grown after a crop of wheat or oats, but the velvet bean requires a long growing season in which to reach full development, and it will pay best to give up the land to it during an entire season.

There are two other leguminous crops, Hairy Vetch and Crimson Clover, that make their growth during the winter and early spring. By sowing these seeds between the standing cotton stalks in October and cultivating them in lightly, the growing crops will occupy the land during the winter, thus preventing the leaching and washing away of fertility by the winter rains. They will be ready to cut for hay by the first of May in time to put in a late cotton crop on the stubble, or if preferred they may be plowed down in April and the cotton can be planted at the usual time. In either case the soil will be gradually improving year by year and the loss from rust will be decreasing, and that without losing the use of the land for a single cotton crop. Under the practice now usually prevailing exactly the reverse of this is the case. The soils are being rapidly depleted of their fertility and the losses from rust are becoming heavier and heavier. Of these two crops vetch is for several reasons decidedly preferable and its greatly extended use cannot be too strongly urged. Directions for seeding and for the soil inoculation that is necessary for success with this crop will be found in Bulletins 87, 96, and 105 of this Station.

Our knowledge of this much discussed and complex disease may be summarized as follows:

Cotton rust is a composite disease, being due partly to physiological derangements caused by improper soil conditions, and partly to the attacks of a number of

facultative fungus parasites, among which the most important are *Macrosporium nigricantium* Atk. *Alternaria sp.*, *Cercospora gossypina* Cke. and *Colletotrichum Gossypii* South.

The plants would largely recover from the physiological derangement on the advent of more favorable weather if it were not for the attacks of the fungi.

On the other hand the fungi are not able to attack plants that are in a vigorous growing condition.

In some cases the lack of vigor that permits these fungus attacks is due to too much standing water in the soil. Such cases can be remedied by drainage.

In other cases it is due to the lack of some chemical element in the soil, usually potash, when the remedy consists in supplying the needed element in the fertilizer.

In the great majority of cases lack of vigor is due to the exhaustion of the soil humus thus greatly reducing its water holding and drouth resisting capacity. In such cases the potash is also usually exhausted. The remedy consists in restoring the vegetable matter needed to form humus by plowing in leguminous crops and in supplying the needed mineral fertilizers.

RED RUST.*

This name is usually applied to a peculiar reddening of cotton foliage due to the attacks of a mite, *Tetranychus telarius*, which resembles the "red spider" of greenhouses in its habits and causes very similar injuries. It is of rather common occurrence in North Alabama, usually on newly cleared lands, and it has been observed doing conspicuous injury in a few fields near Auburn. Judging from the older accounts of cotton diseases, it occurs quite widely in most of the cotton growing

* Bibliography, Nos. 1, 2, 5, 6, 9, 10, 13, 29, 31.

States. Its injuries are often confounded with those produced by other causes. It seldom invades entire fields, but is usually confined to limited patches or areas. The mite multiplies rapidly during hot dry weather, but it is held in check by rains. While locally troublesome it can only be classed among the minor enemies of the cotton plant. So far no remedial measures have been tried. Judging from experience with the allied greenhouse pest the prospects for finding a practicable remedy are not flattering.

The suffused reddening of the foliage due to premature ripening so often seen on sterile rocky hillsides can hardly be called a disease. It is simply starvation and can be promptly remedied by ameliorating the soil conditions.

According to Atkinson* the term Red Rust is sometimes applied to certain stages of the true or black rust when the fungus spots on the leaves are surrounded by a reddish border. This is certainly not a common use of the term. In my experience farmers employ it almost exclusively for the injury caused by mites.

LEAF BLIGHT.†

When the fungus, *Cercospora gossypina* develops alone on the leaves the resulting condition may properly be called leaf blight. The fungus occupies deadened whitish areas 1-2 c. m. in diameter. These are usually surrounded by an indistinct reddish border. Scattered spots of it may appear at almost any stage of the growth of the plant. When acting alone it is usually a disease of minor importance, but it is very widespread and it frequently merges into the rust for this is one of the fungi associated with that disease.

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* Ala. Bull. 27:6.

† Bibliography Nos. 5, 6, 7, 9, 10, 13, 38.

The perfect or ascus bearing stage of this fungus was first detected by Atkinson, who called it *Sphaerella gossypina*. As has been recently pointed out * the generic name *Sphaerella* is not tenable for this group of fungi as it had been previously employed for a different class of plants and the name *Mycosphaerella* has been proposed instead. Our cotton fungus, therefor, will have to be called *Mycosphaerella gosspyina*. The so-called *Cercospora* is only the early or immature conidial stage of the fungus, but, as in so many other cases, it is in this stage that the injury is done.

COTTON MILDEW. †

In late summer and fall the under surface of the leaves of cotton growing in moist places is often covered by white frosted areas. These are usually rather small and angular, being bounded by the veinlets of the leaf, but sometimes they become confluent, covering the entire leaf surface. This frosted appearance is due to the growth of a fungus, *Ramularia areola* Atk. It results in the rather premature falling of the affected leaves, but as it usually only occurs on rank plants in low moist places this partial defoliation coming so late in the season does no appreciable damage.

No remedies have been tried for this disease. If it should ever be worth the while it could doubtless be held in check by spraying with fungicides, but the spraying of a field crop like cotton is a task that will seldom be undertaken.

ANGULAR LEAF SPOT. ‡

In the first stages of this disease clear watery spots are seen in the leaves. These are usually bounded by the

* See Engler-Plantl. Nat. Plantz Fam 1:1:423.
† Bibliography Nos. 3, 10, 13. Syn. Areolate Mildew.
‡ Bibliography Nos. 5, 6, 10, 13.

veins and are thus somewhat angular. Sometimes these transparent spots are confluent along both sides of one of the larger veins or ribs. At this stage of the disease these spots are swarming with bacteria. Later the spots become bounded by a blackish border, the leaf tissue of the spot becomes dry and dead, and often finally breaks away, leaving a jagged hole. This disease is very widely distributed. It is doubtful if there is a cotton field in the State entirely free from it. It usually first appears in June or early July or from two to six weeks earlier than the rust, though it is often found in connection with that disease, when it contributes not a little to the defoliation of the plants. When acting alone it seldom involves a sufficiently large portion of the leaf surface of the plant to prove very detrimental, but it doubtless aids in lowering the vitality of the plant and thus paves the way for the attacks of the rust fungi.

In his earlier accounts of the disease Atkinson attributed it to the action of the bacteria that always accompany it in its early watery stages. Later, owing to the failure of some inoculation experiments he seems to have changed his views for he includes it among the diseases due primarily to physiological causes. My own observations favor the former theory as the disease is by no means confined to plants that are lacking in vigor, and it usually appears at the season of the year when the cotton is making its most vigorous growth. I am of the opinion that the disease is directly due to the action of the accompanying bacteria, that they are able to develop in vigorous healthy leaf tissues, and that in many cases, at least, the cotton aphis is instrumental in spreading the contagion. These views, however, require confirmation, as the disease greatly needs further study. No remedies have been proposed.

COTTON BOLL ROT.*

The rotting of the unripe bolls often causes serious loss to the cotton grower. During the wet Fall of 1898 there were instances where almost the entire crop of some fields was lost, and there were considerable areas in different parts of the State where the percentage of loss was very heavy. Owing to the prevailing dry weather the loss during 1899 has been comparatively small. Like the rust this seems to be a composite trouble that cannot be traced to any one uniform cause. Unlike the rust, however, it is not as a rule the poor, worn out lands that suffer from it. It causes its worst injury on the richest lands where the growth of the cotton is rankest and most vigorous. Although it has been observed since the early years of the century our knowledge of this disease is very fragmentary. The following remarks regarding it must largely be taken as suggestions of probabilities rather than as statements of proven facts. Stedman, who studied the disease, thought that he had discovered the cause in a germ that he called *Bacillus gossypina*. His results have not been fully confirmed. In 1897 C. F. Baker investigated a serious outbreak of boll rot near Dadeville, Ala. He came to the conclusion (not before published) that the primary cause of the disease, at least in the case under investigation, was the puncture of the boll by one of the small leaf hoppers sometimes known as "sharpshooters." †

He found these insects very abundant in the infested fields, and brought back numerous specimens of the

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*Bibliography Nos. 13, 15, 29, 31, 37, 43 45.

†In a recent letter Mr. Baker says: "The Tettigonid "sharpshooters" most conspicuous in the work at Dadeville were two species of the genus *Diedrocephala* as that genus has been recognized by American entomologists. These two occurred in greatest numbers, but a few others, Jassids and Tettigonids were also involved.

bolls in all stages from the fresh puncture to complete rottenness. In the Laboratory various organisms were isolated from these rotting bolls, including at least three species of *Bacillus, Colletotrichum Gossypii, Fusarium sp., Alternaria sp., Rhinotrichum macrosporum* and *R. tenellum.* One of the bacilli was the red pigment producing *B. prodigiosus.* Most of these organisms were doubtless mere saprophytes feeding on the broken-down tissues of the boll. Which one or ones it was that first invaded the insect punctures and started the rot could not be determined with certainly. Field inoculations were made with the different bacilli, but without success. The inoculation punctures in the bolls dried down without producing rot. This, perhaps, should have been expected as the weather was by this time dry and the bolls inoculated were on rather small, feeble plants. The rot only occurs in nature during wet weather or on plants that are so rank as to fully shade the ground thus preventing the drying off of the dew and maintaining a moist atmosphere. It was impossible to decide whether either of the germs was the one isolated by Stedman.

Whether the organisms that produce rot are always dependent on insect punctures for gaining an entrance to the boll is perhaps an open question. There is some evidence that when the plants are rank and the weather wet insect punctures are not always necessary. *Colletotrichum Gossypii*, at least, among the species enumerated above as developing on the rotting bolls, is known to be an active parasite. Quite possibly its attacks on the carpels may so injure the tissue as to admit the other organisms to the immature lint which seems to furnish so favorable a nidus for their growth. On the other hand Stedman's hypothesis of an actively parasitic germ, able in some unknown way to gain entrance to the bolls unaided, may in some cases be the correct one. The

whole subject is very obscure and there is great need for farther careful investigation. The disease has not been prevalent in the fields near Auburn which has rendered study of it difficult.

In any event the fact seems well established that it is the rankest, most luxuriant cotton that is most subject to boll rot. This suggest the following practical recommendations for lessening its injuries. 1st to avoid as far as possible planting cotton on lands that produce an excessive growth of stalk or "weed." Such lands are usually more valuable for corn and hay. 2nd. If necessary to plant on such lands give more space between the rows than is the common practice. This will give better circulation of air and will tend to dry the plants more quickly. 3rd. On such lands use acid phosphate freely and no other fertilizer. Even on soils so rich that no fertilizer is ordinarily used the acid phosphate will be profitable on account of its well known tendency to promote fruitfulness and early maturity rather than a rank growth of stalk. Nitrogenous fertilizers should particularly be avoided on such soils. 4th. Plant the short growing, early maturing varieties, rather than the rank long-limbed late kinds. In other words, the treatment where boll rot is feared should be largely the reverse of that indicated for combating rust. In that case we want to promote vigor of stalk and foliage by all possible means, here the object should be to reduce over-luxuriance and provide for the free circulation of air and the rapid drying off of the plants.

ANTHRACNOSE OF THE BOLL.*

The fungus *Colletotrichum Gossypii* is an active parasite of the cotton plant in all stages of its growth. It attacks the stems of young seedlings near the ground,

* Bibliography Nos. 8, 10, 13, 27, 42.

causing death, much as in damping off. It produces characteristic lesions on the margin of the seed leaves, especially where the latter are caught and impeded in growth while trying to escape from the hull. It develops on the leaf—scars on the stem, and on feeble or injured leaves being one of the fungi associated with rust. It causes a blight of the bark of the twigs and larger stems, but its most conspicuous injuries are to the bolls. It is very common in all cotton fields to see the bolls when approaching maturity lose their green color and assume, especially on the side exposed to the sun, a dull red or bronzed color. This change in color is due to the growth of the mycelium of this fungus in the carpels. If the invasion has not taken place till the boll is nearly mature and the weather is not too wet the fungus may not reach the fruiting stage, or at least it will produce spores sparingly and inconspicuously, and the boll may open quite normally, so that no material damage results. This is very frequently the case. At other times the fungus causes a premature dying of the tissues of the carpels, causing them to crack open, thus exposing the immature lint which may rot in consequence. If too mature to rot, the carpels do not open freely, making the lint hard to pick. It is only under conditions especially favorable to it that the fungus produces the peculiar spotting, and the pustules filled with pink spores, that have been figured as characteristic of the disease. In very many cases bolls and stems are affected by the fungus that do not show these symptoms at all.

It has been found by Atkinson that scalding the seed before planting prevented the appearance of this fungus on seedlings grown for experimental purposes in the greenhouse, probably by destroying spores that were lodged on the lint, and he has suggested this treatment of the seed as a possible remedy for the disease under

field conditions. The proposed remedy has not been tried in the field, and in fact it gives little promise of success since the plant is liable to infection at any stage of its growth ,and the crop is so universally grown that any treated area would almost inevitably become infested from neighboring plantations before the close of the season. No other remedy has been suggested. The disease causes in the aggregate very serious losses.

SHEDDING OF BOLLS.*

Young cotton bolls often fall as the result of injury by the boll worm or other insects, but the term "shedding" is usually applied to a falling of the bolls that is not caused by insect or fungus injuries. It seems to be entirely a physiological trouble and to be dependent on soil and weather conditions. The trouble has not been sufficiently studied to admit of any definite statements as to the predisposing causes. Some varieties or classes of varieties seem to be more subject to shedding than others. The texture and moisture holding capacity of the soil doubtless has a considerable influence. In some cases the character of the fertilizer used has a marked effect on shedding. † Probably, however, the character of the season and the abundance or absence of rainfall has more to do with shedding than any other factor. During a period of seasonable rains the plant puts on as many bolls as it could carry to maturity if these favorable conditions were to continue. If now a period of drouth comes on the lessened water supply in the soil

*Bibliography Nos. 10, 13, 29, 31.

† See Ala. Bull 99:304. On very poor sandy land plots with only phosphate and with phosphate and kainit shed the bolls of the top crop badly, while those with complete fertilizer set and carried a full top crop.

prevents the taking in by the roots of a sufficient quantity to meet the needs of the crop, and as a measure of self-protection the plant throws off part of its load. Again a plant may be carrying a good crop of bolls during a comparatively dry period in which case growth of stalk will have largely ceased, and the food elaborated by the leaves is practically all going to develop the fruit. If now rains come on, a rapid new growth of stalk may be induced that will divert the prepared food from the bolls, and thus cause some of them to fall, or if the rains are very heavy and prolonged the soil may become so water-logged as to cause the dying of some of the feeding rootlets and root hairs, thus deranging the nutrition of the plant. At the same time, the continued dark, cloudy weather would interfere with the normal action of the leaves. Whatever the physical explanation it is a frequently observed fact that sudden changes in weather conditions either from wet to dry or from dry to wet will affect the plant unfavorably and cause shedding. Of course these conditions of weather are beyond our control and in so far as they are the active cause of shedding it will be impossible to avert the trouble. Such a system of soil preparation, cultivation and fertilization as will tend to keep the plant in the best possible condition of thrift and vigor will do much to minimize the bad effects of unfavorable weather.

The trouble is a serious one, often causing the loss of a considerable percentage of the crop. It should be studied until the effect on fruitfulness of each of the factors constituting the environment is fully understood.

List of Fungi Recorded as Growing on Cotton or the Cotton Plant.

Aecidium Desmium B. & Br. Fungi of Ceylon No. 850 Sacc. Syl. Fung. 7:782.

On leaves of *Gossypium*, Island of Ceylon.

Aecidium Gossypii E. & E. Erythea 5:6—1897.

On leaves of *Gossypium*, Lower California.

Alternaria sp.

An undetermimed species mentioned by Atkinson as one of the fungi associated with cotton rust in Alabama. Bot. Gazette 16: 61–65. Ala. Exp. Sta. Bull. 27:6–10.

Alternaria tenuis Nees. Syst. d. Pilze 2:72. Sacc. Syl. Fung. 4:545. On leaves and stems of various plants in Europe and North America. Said by Gasparrini to be associated with a disease of cotton in Italy known as "Palagra."

Bacillus gossypinus Stedman. Ala. Exp. Sta. Bull. 55:6. Apr. 1894. In rotting cotton bolls in Alabama. Figured and described as causing a boll rot of cotton.

Bacillus prodigiosus.

Mentioned in this publication, p. 312, as isolated from rotting cotton bolls in Alabama.

Botryosphaeria Berengeriana DeNot. Sfer. Ital. 82. Fig. 90. Sacc. Syl. Fung. 1:457. On various trees and shrubs in Europe and America. Atkinson, Bull. Cornell Uni. 3:11 refers to this species, on the authority of Dr. Massee who examined the specimens, his No. 2354 on capsules of *Gossypium herbaceum* from Alabama. Ellis, N. A. Pyrenomycetes p. 546 gives this as a synonym for *Botryosphaeria fuliginosa* (M. & N.) E. & E. while Saccardo, Syl. Fung. 1:456 gives *Sphaeria fuliginosa* M. & N. as a synonym for *Botryosphaeria Quercuum* (Schw.) Sacc.

Botryosphaeria horizontalis (B. & C.) Sacc. Syl. Fung. 1:463.

Syn. *Melogramma horizontalis* B. & C. Grev. 4:9°.

On stems of cotton from South Carolina, Ravenel No. 1892.

Botryosphaeria subconnata (Schw.) Cke. Grev. 13:101.

Syn. *Sphaeria subconnata* Schw. Syn. N. A. Fungi No. 1443. *Thuemenia valsarioides* Rehm. Thuem. Myc. Univ. No. 2166.

On stems of cotton, Carolina, Schweinitz; Georgia, Ravenel.

Cercospora gossypina Cke.

See Mycosphaerella gossypina (Cke.) Earle.

Cercosporella Gossypii Speg. Guar. 1;162.

Sacc. Syl. Fung. 10:565. On cotton leaves, Brazil.

Chaetomium olivaceum C. & E. Grev. 6:96.

Sacc. Syl. Fung. 1:225, on dead stems of *Erigeron* New Jersey. Atkinson refers here specimens on dead stems of cotton from Alabama. Bull. Cornell Uni. 3:6.

Cladosporium herbarum (Pers.) Lk.

Developing on cotton roots killed by *Ozonium* and placed in a moist chamber. Pammel Tex. Exp. Sta. Bull. 7:20.

Cleistotheca papyrophila Zuk. Mykol. Mitheil, p. 4. (Bot. Zeitsch). Sacc. Syl. Fung. 11:270. On cotton fiber, Austria.

Colletotrichum gossypii South. Jour. of Myc. 6:101. Sacc. Syl. Fung. 10:469. Also Atkinson in Jour. of Myc. 6:175, Ala. Exp. Sta. Bulls. 17:8 and 41:40. Abundant in Alabama and other Southern States causing anthracnose of the bolls and stems, also on the leaves associated with rust.

Dyplodia gossypina Cke. Grev. 7:95. Sacc. Syl. Fung. 3:366. On dead capsules of cotton, Bombay, India, and Washington, U. S. A. Atkinson, Bull. Cornell Uni. 3:29 refers here to specimens from Alabama.

Diplodia herbarum (Corda) Lev. Ann. Sci. Nat. 1846, p. 292.

Syn. *Sporocadus herbarum Corda*, Ic. 3, fig 63.

Sacc. Syl. Fung. 3:370. On dead stems of various plants, including cotton, Europe, Algeria, North America.

Diplodiella Cowdelli (B. & Br.) Sacc. Syl. Fung. 3:377.

Syn. *Diplodia Cowdelli B. & Br.* Ann. N. H. No. 406.

On cotton paper, England.

Doassansia Gossypii Lagh. Jour. of Myc. 7:49.

Sacc. Syl. Fung. 11:235. On leaves of *Gossypium*, Ecudor.

Dothiorella botryosphaerioides Sacc. Mich 1:145. Sacc. Syl. Fung. 3:242. On stems of *Gossypium* South Carolina, (Ravenel).

Eurotium sp.

Atkinson, Div. of Exp. Sta. U. S. Dept. of Agr. Bull. 33:307, mentions this as appearing in cultures from diseased cotton roots from Texas.

Fusarium sp.

Atkinson, Div. of Exp. Sta. U. S. Dept. of Agr. Bull. 33:307, common on cultures from diseased cotton roots from Texas.

Fusarium aurantiacum (Lk.) Sacc. Syl. Fung. 3:720.

Syn. *Fusisporium aurantiacum Lk.* Obs. 1:17.

Mentioned in Sacc. Syl. Fung. 13:538 [Host Index] as occurring on stems of *Gossypium herbaceum.*

Fusarium oxysporum Schlecht. Fl. Berol. 2:139. Sacc. Syl. Fung. 4;705. Specimens on bolls of *Gossypium herbaceum* from Alabama are referred to this species by Atkinson. Bull. Cornell Uni. 3:49.

Fusarium vasinfectum Atk.

See Neocosmospora vasinfecta (Atk.) E. F. Smith.

Gibberella pulicaris (Fr.) Sacc. Mich. 1:43.

Syn. *Sphaeria pulicaris Fr.* Syst. Myc. 2:417. Given by Sydow in Host Index Sacc. Syl. Fung. 23:538 as occurring on *Gossypium herbaceum.*

Licea Lindheimeri Berk? Grev. 2:68.

Mentioned by Atkinson as occurring in cultures from diseased cotton roots from Texas. Div. of Exp. Sta. U. S. Dept. of Agr. 33:307.

Macrosporium gossypinum Thuem, Herb. Myc. oeconom. No. 513. Sacc. Syl. Fung. 4:526. On dead stems of *Gossypium herbaceum*, South Carolina, (Ravenel).

Macrosporium nigricantium Atk. Bot. Gazette, 16:62. Ala. Exp. Sta. Bull. 27:8; Sacc. Syl. Fung. 10:676 (under the name *M. nigricans* Atk). Abundant on living or languishing cotton

leaves throughout the Gulf States associated with the disease called rust.

Mucor Mucedo L.

Reported by Atkinson, Div. of Exp. Sta. U. S. Dept. of Agr. 33:107 as occurring in cultures of diseased cotton roots from Texas.

Mycosphaerella gossypina (Cke.) Earle, this publication, p. 309. Syn. *Cercospora gossypina* Cke. Grev. 12:21.

Sphaerella gossypina Atk. Bull. Torr. Bot. Cl. 18:300.

The *Cercospora* stage of this fungus is common on cotton leaves in the Gulf States causing leaf blight. It is also associated with rust.

Neocosmospora vasinfecta (Atk.) E. F. Smith. Div. of Veg. Pys. and Path. U. S. Dept. of Agr. Bull. 17:46. 1899.

Syn. *Fusarium vasinfectum Atk.* Ala. Exp. Sta. Bull. 41:26. The conidial stage is parasitic within the stem of the cotton plant causing wilt. Frequent in the Gulf States.

Oedocephalum echinulatum Thax. Bot. Gaz. 16:17.

Sacc. Syl. Fung. 10:522. Reported by Atkinson, Div. of Exp. Sta. U. S. Dept. of Agr. 33:307 as occurring in cultures of diseased cotton roots from Texas.

Olpitrichum carpophilum Atk. Bot. Gaz. 19:244.

Sacc. Syl. Fung. 11:594. On rotting cotton bolls in Alabama.

Ophiobolus porphyrogonus (Tode) Sacc. Syl. Fung. 2:338.

Syn. *Sphaeria porphyrogona Tode* Meckl. 2;12.

On many herbaceous stems Europe and America. Specimens on dead cotton stems from Alabama are so determined by Atkinson, Bull. Cornell Uni. 3:8.

Ozonium sp.

Pammell, Texas Exp. Sta. Bulls. 4 and 7. Atkinson, Bot. Gaz. 18:16–19. Div. of Exp. Sta. U. S. Dep. of Agr. Bull. 33, 300–308, causing a serious root rot of cotton and other plants and trees in Texas. Pammel referred it provisionally to the species *O. auricomum Lk.* Atkinson decides that it cannot be that species. No fruiting forms have been observed.

Penicillium candidum Lk.

Penicillium Duclauxi Delacr.

Penicillium glaucum Lk.

All three of the above species of *Penicillium* developed in cultures of diseased cotton roots from Texas. Atkinson, Div. of Exp. Sta. U. S. Dept. of Agr. Bull. 3 :307.

Pestalozziella gossypina Atk. Cornell Uni. Bull. 3:38.

On dead stems of cotton from Alabama.

Phlyctaena Gossypii Sacc. Mich. 2:144 (as *Septoria*).

Sacc. Syl. Fung. 3:595. On stems of cotton, Carolina, Ravenel; Alabama, Atkinson, Cornell Uni. Bull. 3:30.

Phoma corvina Rav. Grev. 17:75. Sacc. Syl. Fung. 10:171.

On branches of *Gossypium*, South Carolina.

Phoma Gossypii Sacc. Mich. 2:144. Syl. Fung 3:121.

On stems of *Gossypium*, Carolina, Ravenel; Alabama, Atkinson, Cornell Uni. Bull. 3:30.

Phyllosticta gossypina Ell. & Martin. Jour. of Myc. 2:129. Sacc. Syl. Fung. 10:130. On fading leaves of cotton, F. L. Scribner; Alabama, Atkinson, Cornell Uni. Bull. 3:31.

Pleospora nigricantia Atk. Cornell Uni. Bull. 3:9.

On fallen leaves of *Gossypium herbaceum* that were attacked by *Macrosporium nigricantium.*

Polyporus (or Trametes) sp.

On cotton roots, developing on a brown mycelium quite distinct from the *Ozonium.* Pammel, Tex. Exp. Sta. Bull. 7:18.

Pyrenophora hyphasmatis Ell. & Ev. Jour. of Myc. 4:77 (or as quoted by Saccardo owing to error in pagination 4:65) Sacc. Syl. 9:805. On exposed cotton cloth, Louisiana.

Ramularia areola Atk. Bot. Gazette, 15:166. Ala. Exp. Sta. Bull. 41:55-58. On living cotton leaves in the Gulf States causing mildew.

Rhinotrichum macrosporum Farl. Mich. 2:148. Sacc. Syl. Fung. 4:91. On rotten wood. Mass. On dead capsules of *Gossypium herbaceum,* Alabama, Atkinson, Cornell Uni. Bull. 3:39.

Rhinotrichum tenellum B. & C. Grev. 3:109. Sacc. Syl. Fung. 4:91. On rotten onions So. Car.

On dead capsules of *Gossypium herbaceum*, Alabama, Atkinson, Cornell Univ. Bull. 3:39.

Rhizoctonia sp.

Sterile damping off fungus, Atkinson, Ala. Exp. Sta Bull. 41:30-39. Cornell Exp. Sta. Bull. 94:265-268. Duggar, Cornell Exp, Sta. Bull. 163:330-352. Causing a damping off of cotton seedlings, and the disease known as sore shin.

Rhizopus nigricans Ehrb. De Mycetog, Nova Acta. 19:108. Sacc. Syl. Fung. 7:212. A common mould.

On tissues of cotton seedlings that have died from damping off. Atkinson, Ala. Exp. Sta. Bull. 41:31.

Saccharomyces sp.

Atkinson, Div. of Exp. Sta. U. S. Dept. of Agr. Bull. 33:307 mentions a "pink yeast" as occurring in cultures of diseased cotton roots from Texas.

Sclerotium sp. An undetermined species causing Rolf's "Sclerotium Wilt" of various plants. Mentioned by E. F. Smith, Div. of Veg. Phys. & Path. U. S. Dept. of Agr. Bull. 17:44, as causing a wilt of cotton in Florida.

Septoria gossypina Cke. Grev. 12:25

Sacc. Syl. Fung. 3:516. On leaves of *Gossypium*, Carolina, Ravenel.

Sphaerella gossypina Atk.

See Mycosphaerella gossypina (Cke) Earle.

Sporotrichum chlorinum Link. Obs. Myc. 2:35.

Sacc. Syl. Fung. 4:112. Occurring in cultures from diseased cotton roots from Texas. Atkinson, Div. of Exp. Sta. U. S. Dept. of Agr. Bull. 33:307.

Thielavia basicola Zopf. Verhand, Bot. Brand, p. 101. Sacc. Syl. Fung. 1:39. Making wounds in cotton stems beneath the surface of the earth, E. F. Smith, Div. of Veg. Phys. & Path. U. S. Dept. of Agr. Bull. 17:38.

Torula incarcerata Cke. Grev. 1:90.

Sacc. Syl. Fung. 4:258. Causing a disease of cotton seeds in India.

Tricothecium roseum (Pers.) Lk. Obs. Myc. 1:16.

Syn. *Trichoderma roseum* Pers. Syn. Fung. p. 231.

Sacc. Syl. Fung. 4:178. On decaying carpels of *Gossypium*, Atkinson, Cornell Uni. Bull. 3:39.

Uredo Gossypii Lagh. Jour. of Myc. 7:48.

Sacc. Syl. Fung. 11:224. Causing a destructive rust of the foliage of *Gossypium* in Ecuder.

Valsa gosspinay Cke. Valsei of U. S. p. 115 (in Proc. Phil. Acad. Sci. 1877). Sacc. Syl. Fung. 1:127.

On branches of cotton, Carolina, Ravenel.

Verticillium Rexianum Sacc. Mich. 2:577.

Sacc. Syl. Fung. 4:153, occurring in cultures of diseased cotton roots from Texas, Atkinson, Div. of Exp. Sta. U. S. Dept of Agr. Bull. 33:307.

Zignoella funicola (Ell.) Sacc. Syl. Fung. 2:217.

Syn. *Sphaeria funicola* Ell. Bull. Torr. Bot. Club 8:90.

On exposed cotton cord in a grape trellis, New Jersey.

This makes a total of 61 species reported as growing on Gossypium.

Species Excludende.

In examining Mycological literature for cotton inhabiting fungi references have been found to the following species as occurring on *Gossypium* which on investigation prove to be erroneous. These errors have mostly occurred through a misunderstanding on the part of foreign botanists of our popular use of the of the term "cottonwood" for the different species of *Populus*.

Amphisphaeria separans Ell. & Ev. Bull. Torr. Bot. Club 24:130. "On an old cottonwood shingle." This is mentioned by Sydow. Host Index Sacc. Syl. Fung. 13:548 as occurring on wood of *Gossypium*.

Diplodiella striispora Ell. & Barth. Erythera 41:24. "On cottonwood stump." Mentioned by Sydow l. c. as on trunk of *Gossypium*.

Gloeosporium carpigenum Cke. & Hark. Grev. 13:113. "On capsules of cottonwood." This is given in Sacc. Syl. Fung. 10:453 as "*in capsulis Gossypii arborei.*" Miss E. A. Southworth in her article on Anthracnose of cotton, Jour. of

Myc. 6:100, says, "When this fungus [*Colletotrichum Gossypii*] was first brought to our notice some immature specimens were sent to Mr. Ellis who afterward sent them to Mr. Cooke; both agreed that they were identical with *Gloeosporium carpigenum* Cke. & Hark. and the fungus was distributed in Ellis North American Fungi under that name. Through the kindness of Mr. Harkness I have been able to compare it with type specimens of *G. carpigenum* and find it quite distinct from this fungus."

It may be mentioned in this connection that *Gloeosporium carpigenum* Cke. & Hark. on capsules of cottonwood is antedated by *Gloeosporium carpigenum* Cke. Grev. 7:109 on fruits of *Aesculus*, California. As the spore measurements in the two descriptions do not agree it is to be supposed that they are two distinct species, in which case the one on "cottonwood" is without a name.

Hyponectria Gossypii (Schw) Sacc. Syl. Fung. 2:456.

Syn. *Sphaeria Gossypii* Schw. Fung. Car. No. 207. Dr. Erwin F. Smith has conclusively shown, Div. of Veg. Phys. & Path. U. S. Dept. of Agr. Bull. 17:51, that this should be considered *nom. excludendum* as it was founded on a misconception, the type specimen showing only a wrinkling of the capsule, no fungus at all being present.

Macrosporium nigricans Atk. Sacc. Syl. Fung. 10:674. This seems to be a missprint for *Macrosporium nigricantium* which see.

Ozonium auricomum Lk.

Pammell so called the fungus causing root rot of cotton in Texas, but Atkinson decides after farther study of the fungus that it cannot be this species. See *Ozonium sp.*

Sphaeria Gossypii Schw.

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Bibliography of Cotton Diseases.

In the following pages the attempt has been made to bring together the titles of all the papers that have been published on cotton diseases. Owing to limited library

facilities the list is necessarily incomplete and the writer will be greatly obliged for notes on any omitted articles. The papers are arranged alphabetically by authors and as far as possible chronologically under each author. No attempt has been made to list reviews or compilations, but only such papers as give the results of original observation and study. Papers in the agricultural press* or other transient publications are not included.

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1. **Atkinson, Geo. F.—The Cotton Worm and other Enemies of the Cotton Plant.** So. Car. Dept. of Agr. Monthly Rept. Oct. 1888, p. 91. Mention is made of Red Rust as caused by mites, *Tetranychus tetarius.*

2. **Atkinson, G. F.—**So. Car. Exp. Sta. Bull. 4:60. Jan. 1889. Mentions the Red Rust caused by mites.

3. **Atkinson, G. F.—A New Ramularia on Cotton.** Bot. Gazette 15:166-8. July, 1890. A description of the botanical characters of the fungus *Ramularia areola* causing mildew of cotton.

4. **Atkinson, G. F.—A New Root Rot Disease of Cotton.** Ala. Exp Sta. Bull. 21, p. 1-11, Dec. 1890. Describes the attacks of the nematode, *Heterodera radicicola* on cotton roots.

5. **Atkinson, G. F.—Black Rust of Cotton; a Preliminary Note.** Bot. Gazette, 16:61-5, Mch. 1891. A paper read before the Assoc. of Agr. Col. & Exp. Sta's. at Champaign, Illinois, Nov. 1890, giving a brief discussion of the characteristics of the disease and of the fungi accompanying it. He describes as new *Macrosporium nigricantium* and mentions a bacterial leaf disease [angular spot].

6. **Atkinson, G. F.—Black Rust of Cotton.** Ala. Exp. Sta. Bull. 27, pp. 1-16, with two plates, May, 1891. A more extended discussion of the matter presented in the preliminary paper.

7. **Atkinson, G. F.—Sphaerella Gossypina n. sp.—the Perfect Stage of Cercospora Gossypina Cke.** Bull. Torr. Bot. Club, 18:300-301 with plate, Oct. 1891, a botanical description of the fungus.

8. **Atkinson, G. F.—Anthracnose of Cotton.** Jour. of Myc. 6:173-8 with two plates, 1891.

Read before the Assoc. of Agr. Col. & Exp. Sta's. Champaign, Ills. Nov. 1890.

Describes the occurrence of the fungus *Colletotrichum Gossypii* South on different parts of the cotton plant, and its behavior in artificial cultures.

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* A long list of references to newspaper articles on the Texas root rot, of cotton and other plants is given by Pammel at the end of Texas Exp. Sta. Bull. No. 7.

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9. **Atkinson, G. F.—Some Leaf Blights of Cotton.** Ala. Exp. Sta. Bull. 36, pp. 1-32, with two plates, March 1892. Describes rust, under the name of "Yellow Leaf Blight," calls attention to its being primarily a physiological disease, gives history of kainit as a preventive of the disease and discusses the effect of humus. Makes brief mention under the name of "Red Leaf Blight" of a reddening of the leaves, often seen on poor lands, due to poor nutrition.

10. **Atkinson, G. F.—Some Diseases of Cotton**. Ala. Exp. Sta. Bull. 41, pp. 1-65, with numerous figures, Dec. 1892. This was prepared by Dr. Atkinson before severing his connection with the Ala. Exp. Station as a summary of his studies on cotton diseases. It includes a somewhat full discussion of the following topics: General Nature of Cotton Diseases, p. 5. Yellow Leaf Blight or Mosaic Disease [Rust], p. 9. Frenching [Wilt], p. 19. Damping Off or Sore Shin, p. 30. Anthracnose, p. p. 40. Shedding of Bolls, p. 50. Angular Spot of Cotton, p. 54. Areolate Mildew of Cotton, p. 55. Cotton Leaf Blight, p. 58. Root Galls, p. 61.

11. **Atkinson, G. F.—Methods for Obtaining Pure Cultures of Pammel's Fungus of Texas Root Rot of Cotton**. Bot Gazette, 18:18-19, Jan. 1893. Read before Amer. Assoc. Agr. Coll. & Exp. Sta's, New Orleans, Nov. 1892. Describes methods of baiting the fungus.

12. **Atkinson, G. F.—Damping Off.** Cornell Exp. Sta. Bull 94:265-8. Discusses the sterile damping off fungus [*Rhizoctonia*] which is the cause of sore shin in cotton.

13. **Atkinson, G. F.—Diseases of Cotton**. The Cotton Plant, Office of Exp. Sta. U. S Dept. of Agr. Bull. 33, pp. 279-316, with numerous cuts, 1896. This gives a detailed account of all cotton diseases known to occur in North America. It is largely the result of the author's work while connected with the Ala. Exp. Station. The diseases discussed are Mosaic Disease or Yellow Leaf Blight [Rust], Red Leaf Blight [Red Rust in part], Shedding of Bolls, Angular Leaf Spot, Frenching [Wilt], Sore Shin, Damping Off or Seedling Rot, Anthracnose, Root Rot (Ozonium), Cotton Leaf Blight, Areolate Mildew, Cotton Boll Rot, Root Galls of Cotton.

14. **Atkinson, G. F.—Some Fungi from Alabama**. Cornell Uni. Bull. Vol. 3, No. 1, pp 1-50. June, 1897. This mentions among others, 20 species of fungi as occurring on cotton in Alabama, two of which are described as new.

15. **Comstock, J. Henry—Report upon Cotton Insects**. U. S. Dept. of Agr. 1879. Appendix II, p. 384. Mentions cotton boll rot. Dr. Lee reporting from Lowndes Co., Ala., says "From 1825 to 1832 the crop was cut off very much by an infection called 'the rot.' The bolls which were not matured became diseased and sour."

16. **Cooke, M. C.—Blights of Tea and Cotton**, Grevillea, 1:90. Dec 1872. Describes a disease of Cotton seeds in India caused by the fungus *Torula incarcerata* Cke.

17. **Curtis, Geo. W.**—Tex. Exp. Sta. Bull. 22:211-216. Sept. 1882. Discusses a root rot of alfalfa found to be the same as the cotton root rot [*Ozonium*]. Reports experiments that suggest salt as a possible remedy.

18. **Dabney, Chas W.**—Ann. Rept. N. Car. Exp. Sta. for 1882, pp. 68-73. In discussing kainit as fertilizer for cotton he refers at some length to its effect in preventing rust and the shedding of bolls.

19. **Duggar, B. M.—Three Important Diseases of the Sugar Beet.** Cornell Exp. Sta. Bull 163:329-352. Feb. 1899. Discusses the sterile fungus of cotton sore shin in connection with a similar fungus causing a disease of beets and refers it to the genus *Rhizoctonia*.

20. **Duggar, J. F.—Experiments with Cotton**. Ala. Exp. Sta. Bull. 76:22. Jan. 1897. Mentions the failure of kainit in moderate quantity to resist rust in experiments during 1896. With 600 lbs. per acre there was a noticeable effect.

21. **Duggar, J. F.—Co-operative Fertilizer Experiments with Cotton in 1896**. Ala. Exp. Sta. Bull. 78. Feb. 1897. On pp. 63 and 66 are brief notes on the effect of fertilizers on rust.

22. **Duggar, J. F.—Experiments with Cotton**. Ala. Exp. Sta. Bull. 89. Jan. 1898. On pp. 4 and 20 are notes on the effect of kainit on rust.

23. **Duggar, J. F.—Co-operative Fertilizer Experiments with Cotton in 1897**. Ala. Exp. Sta. Bull. 91 Feb. 1898, p. 44. "Kainit greatly reduced the injury from leaf diseases in 61 per cent. of the experiments." There are numerous notes on the effect of kainit in controlling rust.

24. **Duggar, J. F.—Experiments with Cotton in 1898**. Ala. Exp. Sta. Bull. 101, Jan. 1899, pp. 3, 16 and 17 give result of special potash experiments showing marked effect of kainit and muriate of potash in decreasing the amount of rust.

25. **Duggar, J. F.—Co-operative Fertilizer Experiments with Cotton in 1898**. Ala. Exp. Sta. Bull. 102, Feb. 1899. Many brief notes on rust and some mention of boll rot.

26. **Earle, F. S.—Cotton Rust**. Ala. Exp. Sta. Bull 99 pp. 281-309, Dec. 1898. A report on farther investigations of this disease. Atkinson's views are in the main confirmed. Attention is especially called to the necessity for soil improvement in combatting this disease. It is shown that muriate of potash is as effective as kainit in controlling it.

27. **Galloway, B. T.—Anthracnose of Cotton**. Ann. Rept. U. S. Dept. of Agr. 1890, pp. 407-8 with colored plate. A brief account of the disease.

28. **Gasparrini,—Observationi sopra una Malattea del Cottone, &c.** Insti. D'Incorag. Napoli, 1865. Describes a disease known as

Pelagra. *Alternaria tenuis* Nees, and other moulds are associated with it.

29. **Glover, Townend—Accidents and Diseases of the Cotton Plant.** Ann. Rept. U. S. Dept. of Agr. 1855, pp 230-234. Gives an account of the following diseases: "Sore Shin," attributed to careless hoeing, also to twisting by the wind. "Frenching," a name applied to plants with variegated leaves. "Effects of Bad Subsoil," the sudden dying of plants near Tallahassee, Fla. [evidently cotton wilt]. "The Rust." [The author seems to confuse Rust, Red Rust, and probably anthracnose under this term.] "Shedding of Young Buds or Bolls," caused by wet weather. "The Rot," quotes a very full description by Mr. Thorp in American Farmer [no date given].

30. **Lagerheim, G.—Observations on New Fungi from North and South America.** Jour. of Myc 7:44-50. Sept. 1891. Describes *Uredo Gossypii* as a new species causing a serious disease of cotton in Ecudor. Mentions a disease reported from Cuenca under the name of "Cancha" cause not known and describes *Doassansia Gossypii*.

31. **Loughridge, R. H.—Tenth** Census, Vols. 5 and 6. Under the heading "Diseases of Cotton" a brief resume is given of reports from most of the counties in each of the cotton States. The diseases mentioned are Shedding, Boll Rot, Rust, Blight, and Sore Shin. In Texas the term blight evidently refers to Root Rot. In Florida it seems to refer to Wilt. In the other States the terms rust and blight seem to include all leaf diseases of cotton. Read in the light of our present knowledge of cotton diseases these reports are exceedingly interesting and throw much light on geographical distribution.

32. **Lyman, Jos. B.—Enemies of the Cotton Plant.** Ann Rept. U. S. Dept. of Agr 1866, p. 199. Mentions rust, states it is worse on soils of moderate depth that have been long in cultivation. "Rotation of crops and a liberal application of manures, especially those rich in potash and phosphoric acid will in nine cases out of ten give relief."

33. **Newman, J. S.—Experiments with Cotton.** Ala. Exp Sta. Bull. 22:19, Jan. 1891. Calls attention to the effect of kainit in preventing leaf blight [rust].

34. **Newman, J. S.—Co-operative Soil Tests of Fertilizers.** Ala. Exp. Sta. Bull. 23. Feb. 1891. Brief notes on rust.

35. **Pammel, L. H.—Root Rot of Cotton or Cotton** Blight. Texas Exp. Sta. Bull. 4, pp. 1-18, Dec. 1888. Discusses geographical distribution, characteristics, and the various theories to account for it. Ascribes it to the growth on the roots of the fungus *Ozonium auricomum* Lk. as determined by Dr. W. G. Farlow.

36. **Pammel, L. H.—Cotton Root Rot.** Texas Exp. Sta. Bull. 7, pp. 1-30, with 5 plates, Nov. 1899. A fuller discussion than in previous paper. Gives list of host plants for *Ozonium* in Texas and suggests rotation with the serials as the most promising remedy. Mentions Seedling Rot or Sore Shin, p. 7.

37. **Riley, C. V.** 4th Rept. U. S. Ent. Com. p 357, 1885. Describes Boll Rot. Thinks Steele mistaken in attributing it to work of boll worm, states that it has been destructive at times since 1814.

38. **Scribner, F. Lamson.—Cotton Leaf Blight.** Ann. Rept. U. S. Dept. of Agr. 1887, p. 355 with colored plate. Describes *Cercospora gossypina* Cke. States that it is "distinct from the dreaded cotton rust.... and in comparison is of little consequence."

39. **Smith, Erwin F.—The Watermelon Wilt and Other Wilt Diseases due to Fusarium.** Proc. A. A. A. Sci. 44:190, May, 1896. Mentions cotton wilt and the discovery of the ascigerous form of the fungus causing it, considers it probably identical with the wilts of the watermelon and the cowpea.

40. **Smith, Erwin F.—The Spread of Plant Diseases.** Trans. Mass. Hort. Soc. 1897, pp. 128-9. Mentions cotton wilt incidentally as an example of a disease infesting soils. Cites a sea-island cotton grower who has abandoned 15 acres of his best land on account of it

41. **Smith, Erwin F.—Wilt Disease of Cotton, Watermelon and Cow Pea.** U. S Dept. of Agr. Div. of Veg. Phys. & Path. Bull. 17, pp. 1-53, with 10 plates, Nov. 1899. A very full description of the fungus causing the wilt disease of cotton, *Neocosmospora vasinfecta* (Atk.) Smith, with extended culture experiments. He considers it the type of a new genus in the *Nectriaceae*. The forms on watermelon and cowpea are physiological varieties since they do not seem capable of transmission from one host to another, although structurally indistinguishable. An exceedingly valuable paper.

42. **Southworth, Miss E. A.—Anthracnose of Cotton.** Jour. of Myc. 6:100-105 with 1 plate, 1890. A description of the fungus, *Colletotrichum Gossypii* South, which is considered a new species, with notes on the damage to cotton crop and on geographical distribution.

43. **Stedman, J M.—Cotton Boll Rot.** Ala. Exp. Sta. Bull. 55, pp. 1-12 with 2 plates, Apr. 1894. Describes a disease of cotton bolls which he considers of bacterial origin and ascribes to the growth of *Bacillus gossypina* Sted. Cultural notes and inoculation experiments are recorded.

44. **Stelle, J. P.—Cotton Blight.** 4th Rept. U. S. Ent. Com. App. III, p. 25. 1885. Says the disease is also known in Texas as Stalk Rust and Root Rot. Gives a fairly good description, decides it is not due to insects and suggests rotation of crops.

45. **Stelle, J. P.—Boll Rot,** l. c. p. 26. Observes the cotton boll worm to frequently bite into bolls that they do not enter and considers these injuries as the cause of boll rot.

46. **Wailes, B. C. L.—The Cotton Plant; Its Origin and Varieties and its Enemies and Diseases.** Agriculture and Geology of Mississippi, 1st Rept. 1854, pp. 146-148. Not seen.

47. **Watts.—Dictionary of Economic Products of India.** In the chapter on cotton several diseases are mentioned under their native names. They are mostly ascribed to unfavorable weather conditions, but they do not seem to have been scientifically studied.

CLIMATIC CONDITION OF COTTON BELT.*

BY P. H. MELL.

THE GENERAL CLIMATIC FEATURES PREVAILING IN THE SOUTHERN UNITED STATES DURING THE PREPARATION OF THE LAND FOR THE PLANTING OF THE SEED.

The winters of the South are seldom severe, and the temperature rarely reaches zero except in the more northern latitudes of the cotton region, and not often even there. It is a well recognized fact among cotton planters that in those portions of the country where the changes of temperature are sudden and the fall reaches zero during every winter and sometimes frequently during the same winter, the period is too short between frosts to enable the cotton plant to perfect its growth and mature its fruit. Many efforts have been made to force the plant to produce fiber in the northern portions of Kentucky and the colder regions in west and northwest Texas, but all such efforts have proved total failures, even though the general conditions of the soil in those sections of the country are of a nature well suited for the cultivation of cotton.

The following table of winter temperatures at those stations in the cotton region, giving continuous records for ten years or more, is given to bring out the above conclusions in regard to the growth of cotton. A careful study of this table will show that wherever the altitude or latitude causes the temperature to range low during the winter and spring months the cultivation of cotton is correspondingly reduced to a minimum:

*Condensed from "Climatology of Cotton Plant." P. H. Mell, Bulletin 8 U. S. Weather Bureau.